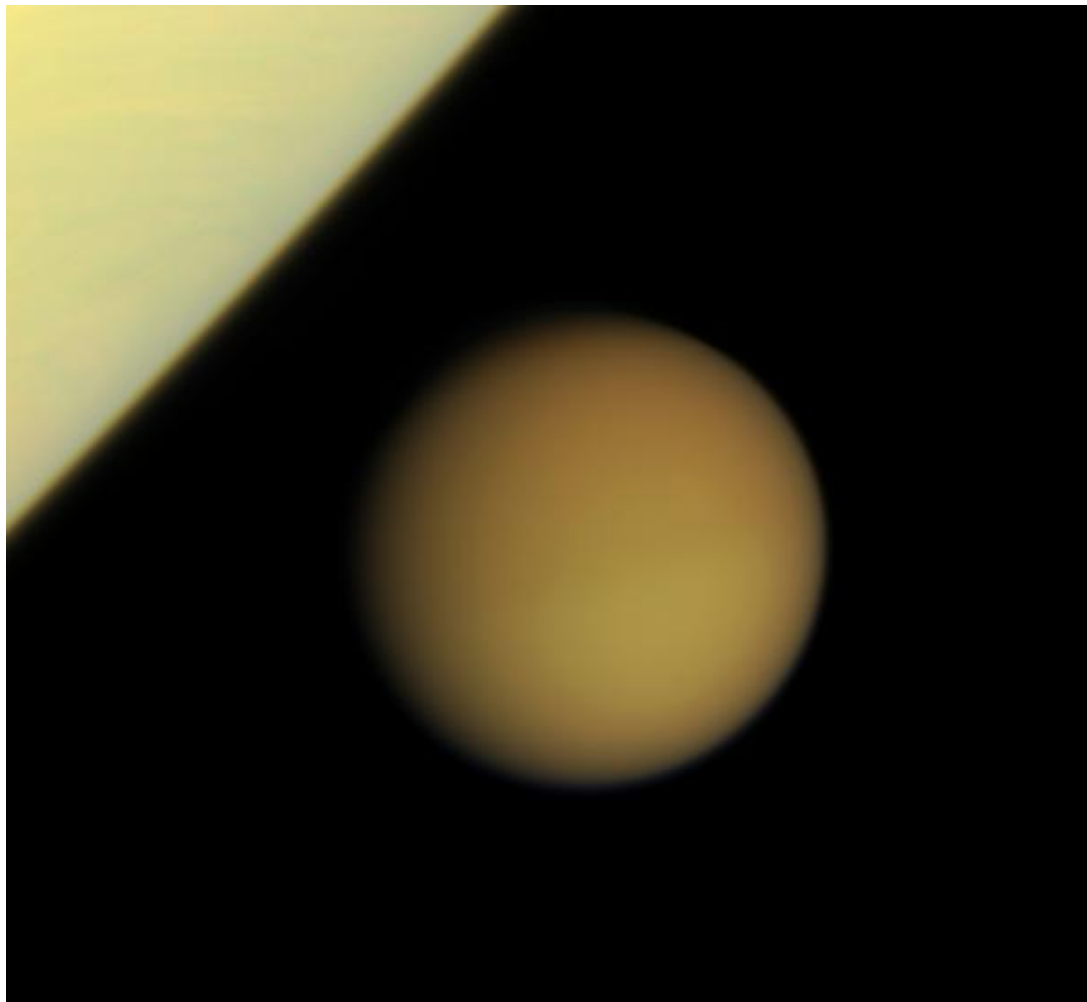


C A S S I N I



TITAN 059TI(T42)
MISSION DESCRIPTION

March 25 2008

Jet Propulsion Laboratory
California Institute of Technology

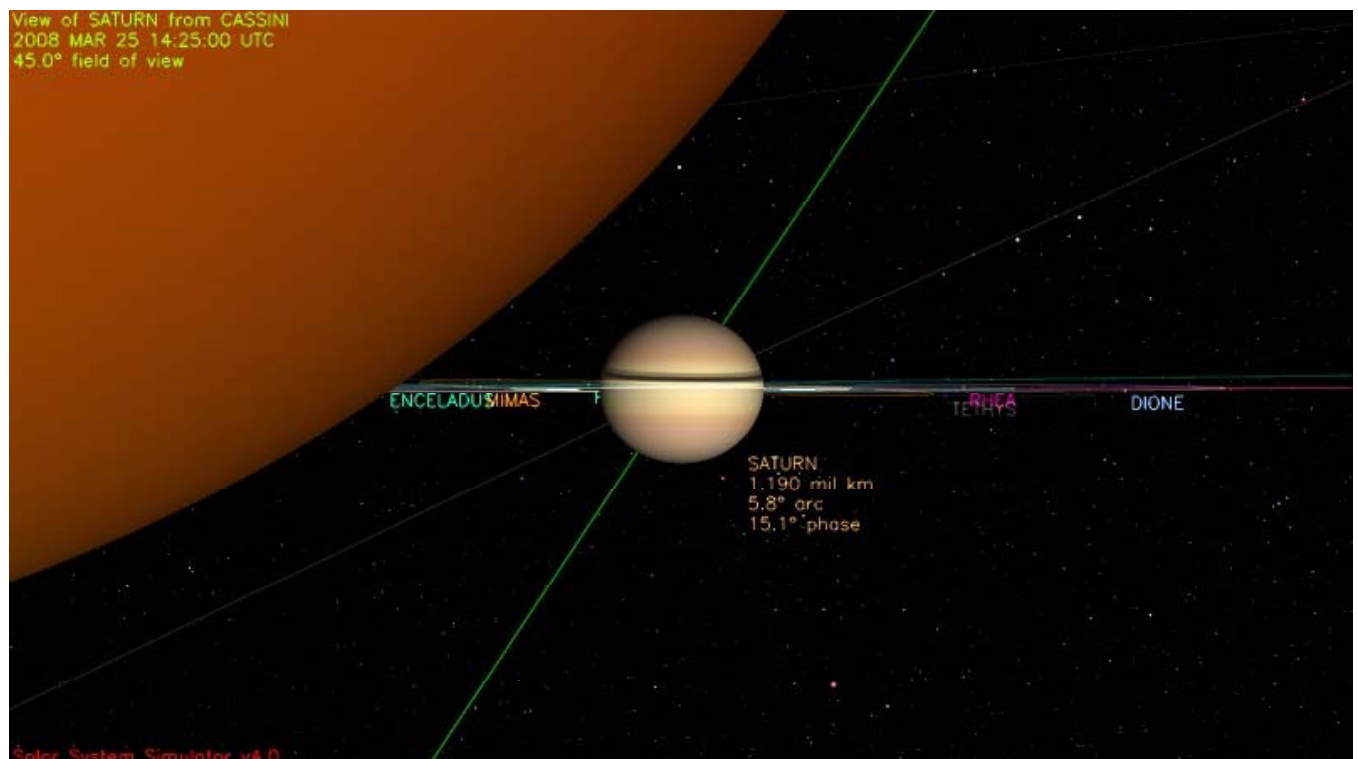
Cover image: Titan Approaches Saturn—Swathed in its thick blanket of atmosphere, frigid Titan approaches the brilliant limb of Saturn. This view was obtained just minutes after the wide-angle view, "Titan Slips Away." Images taken using red, green and blue spectral filters were combined to create this natural color view. The images were acquired with the Cassini spacecraft narrow-angle camera on Jan. 29, 2008 at a distance of approximately 2.3 million kilometers (1.4 million miles) from Titan. Image scale is 14 kilometers (8 miles) per pixel. Credit: NASA/JPL/Space Science Institute

1.0 OVERVIEW

Thirty two days after its previous visit, Cassini returns to Saturn's largest moon for the mission's forty-third targeted encounter with Titan. The closest approach to Titan occurs on Tuesday, March 25, at 2008-085T14:27:48 spacecraft time at an altitude of 1000 kilometers (621 miles) above the surface and at a speed of 6.3 kilometers per second (14,000 mph). The latitude at closest approach is 27 degrees S and the encounter occurs on orbit number 62.

This encounter is set up with two maneuvers: an apoapsis maneuver on March 17, and a Titan approach maneuver, scheduled for March 22. T42 is the seventh in a series of outbound encounters that will last until the end of the prime mission, and it occurs less than two days after Saturn closest approach. This is the last in a series of seven Titan southern hemisphere encounters.

Saturn is obscured by Titan at closest approach, so this image shows the view of Saturn from the spacecraft roughly 3 minutes prior to closest approach.



ABOUT TITAN

If Titan were a planet, it would likely stand out as the most important planet in the solar system for humans to explore. Titan, the size of a terrestrial planet, has a dense atmosphere of nitrogen and methane and a surface covered with organic material. It is Titan that is arguably Earth's sister world and the Cassini-Huygens mission considers Titan among its highest priorities.

Although it is far colder and lacks liquid water, the chemical composition of Titan's atmosphere resembles that of early Earth. This, along with the organic chemistry that takes place in Titan's atmosphere, prompts scientists to believe that Titan could provide a laboratory for seeking insight into the origins of life on Earth. Data from the Huygens probe, which touched down on Titan's surface in January 2005, and the Cassini orbiter has shown that many of the processes that occur on Earth also apparently take place on Titan – wind, rain, volcanism, tectonic activity, as well as river channels, and drainage patterns all seem to contribute in shaping Titan's surface. However, at an inhospitable -290 degrees Fahrenheit (-179 degrees Celsius), the chemistry that drives these processes is fundamentally different from Earth's. For example it is methane that performs many of the same functions on Titan that water does on Earth.

The Huygens probe landed near a bright region now called Adiri, and photographed light hills with dark river beds that empty into a dark plain. It was believed that this dark plain could be a lake or at least a muddy material, but it is now known that Huygens landed in the dark region, and it is solid. Scientists believe it only rains occasionally on Titan, but the rains are extremely fierce when they come.

Only a small number of impact craters have been discovered. This suggests that Titan's surface is constantly being resurfaced by a fluid mixture of water and possibly ammonia, believed to be expelled from volcanoes and hot springs. Some surface features, such as lobate flows, appear to be volcanic structures. Volcanism is now believed to be a significant source of methane in Titan's atmosphere. However, there are no oceans of hydrocarbons as previously hypothesized. Dunes cover large areas of the surface.

The existence of oceans or lakes of liquid methane on Saturn's moon Titan was predicted more than 20 years ago. Radar and imaging data from Titan flybys have provided convincing evidence for large bodies of liquid. With Titan's colder temperatures and hydrocarbon-rich atmosphere, these lakes and seas most likely contain a combination of liquid methane and ethane (both hydrocarbons), not water.

The Cassini-Huygens mission, using wavelengths ranging from ultraviolet to radio, is methodically and consistently revealing Titan and answering long-held questions regarding Titan's interior, surface, atmosphere, and the complex interaction with Saturn's magnetosphere. While many pieces of the puzzle are yet to be found, with each Titan flyby comes a new data set that furthers our understanding of this world as we attempt to constrain scenarios for the formation and evolution of Titan and its atmosphere.

1.1 TITAN-42 SCIENCE HIGHLIGHTS

With apologies to Douglas Adams, while this flyby may not yield the answer to life, the universe, and everything, Titan scientists are hopeful that this southern pass will help crack many Titan mysteries.

- **INMS** This will be the second time in the entire mission when INMS has used its open source neutral beaming mode to see reactive neutrals and understand wall effects, where detected particles end up sticking to the source. The instrument is unable to measure both ions and neutrals at the same time. Part of the Magnetosphere and Plasma Science Titan campaign, this observation will help sort out compositional changes of minor species during ingress vs. egress.
- **VIMS** rides along on the INMS closest approach observations using the so-called "noodle" mode, where VIMS captures a long noodle-shaped swatch of Titan's surface. The noodle mode was first tried in the T20 flyby: the noodle observation, using a RADAR swath for context, showed correlation between interdune terrain and types of ices. If this particular observation is successful, VIMS scientists expect to exploit it more during the extended mission. Pointing is especially tricky for this mode. VIMS is not expected to capture the Huygens landing site, but will get medium resolution imaging of adjacent unknown territory. VIMS non-noodle prime observations during T42 include a mosaic at 5 kilometers per pixel of unknown territory at the northern rim of the dark units and cloud tracking.
- **ISS:** Similar to the T41 encounter, ISS captures regional mapping and full-disk mosaics covering Adiri and East Belet, giving one of our best views of the high northern latitudes and filling in coverage. The team is looking forward to seeing a high resolution image of a complex boundary in that northern region. The instrument may be able to see all the way up to the pole due to scattering by the atmosphere. In addition, the Narrow Angle Camera monitors for surface/atmosphere changes, attempts to see surface color variations, and monitors limb hazes. As the geometries of the T41 through T44 flybys are very similar, we'll be able to monitor how the clouds change in this region every few weeks.
- **CIRS** continues to extend spatial and temporal coverage of Titan, from low-spectral resolution disk maps to high spectral resolution nadir and limb integrations. Getting good time resolution is very important because we are

looking for seasonal changes in the stratosphere, especially the expected break-up of the northern polar vortex in northern spring.

- **RPWS:** As Titan is out “in front” of Saturn, the T41 through T44 flybys put the spacecraft in an ideal location to have another opportunity to see Titan outside of Saturn’s magnetosphere, in shocked solar wind ahead of the magnetosheath as happened on T32. We are interested in duplicating the flyby geometry to look for shorter time-scale phenomena in Titan’s plasma environment, so this series of four flybys, especially T41 through T43, will offer that opportunity.

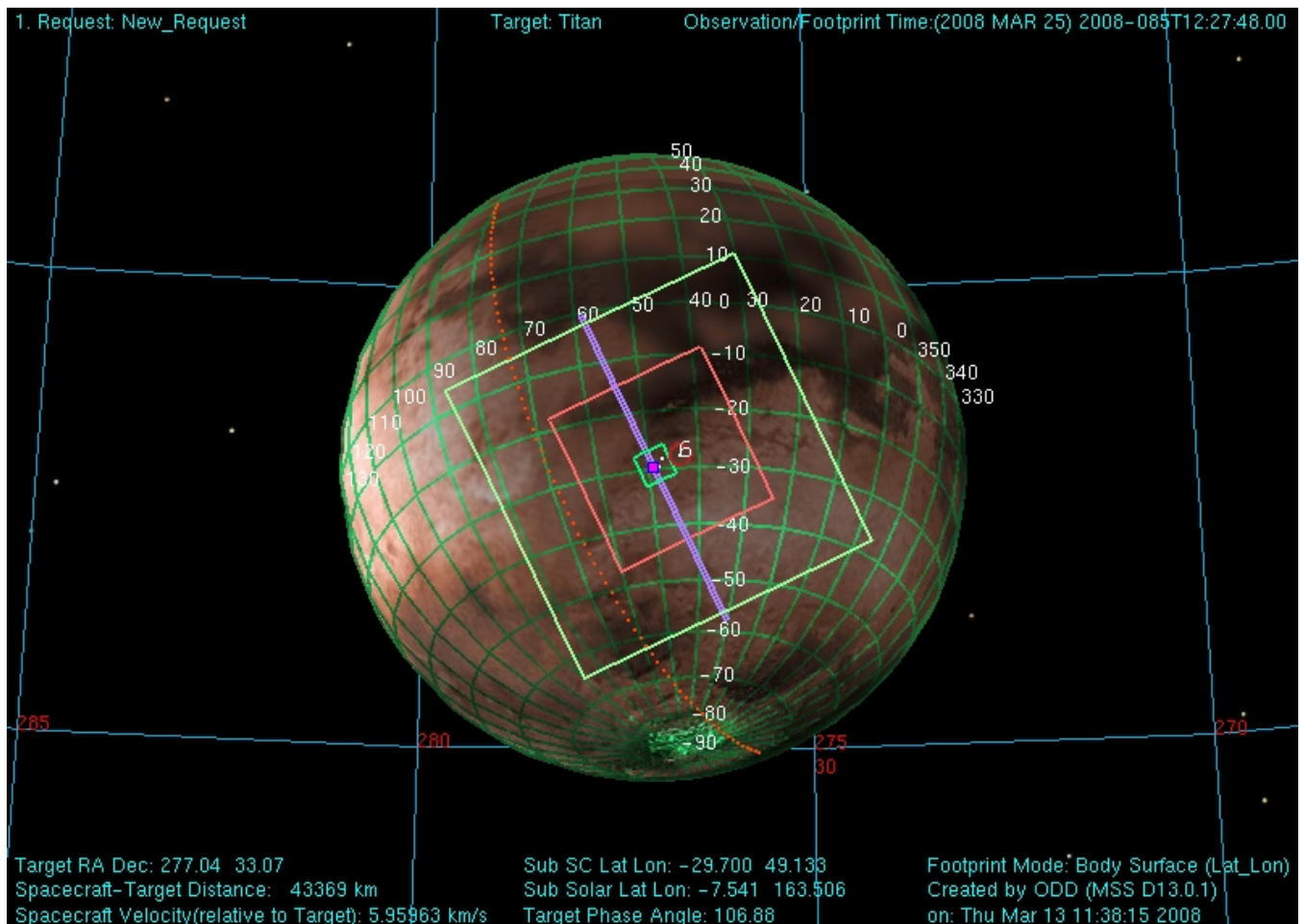
1.2 SAMPLE SNAPSHOTS

Three views of Titan from Cassini before, during, and after closest approach to Titan are shown below. The views are oriented such that the direction towards the top of the page is aligned with the Titan North Pole. The optical remote sensing instruments’ fields of view are shown assuming they are pointed towards the center of Titan. The sizes of these fields of view vary as a function of the distance between Cassini and Titan. A key for use in identifying the remote sensing instruments fields of view in the figures is listed at the top of the next page.

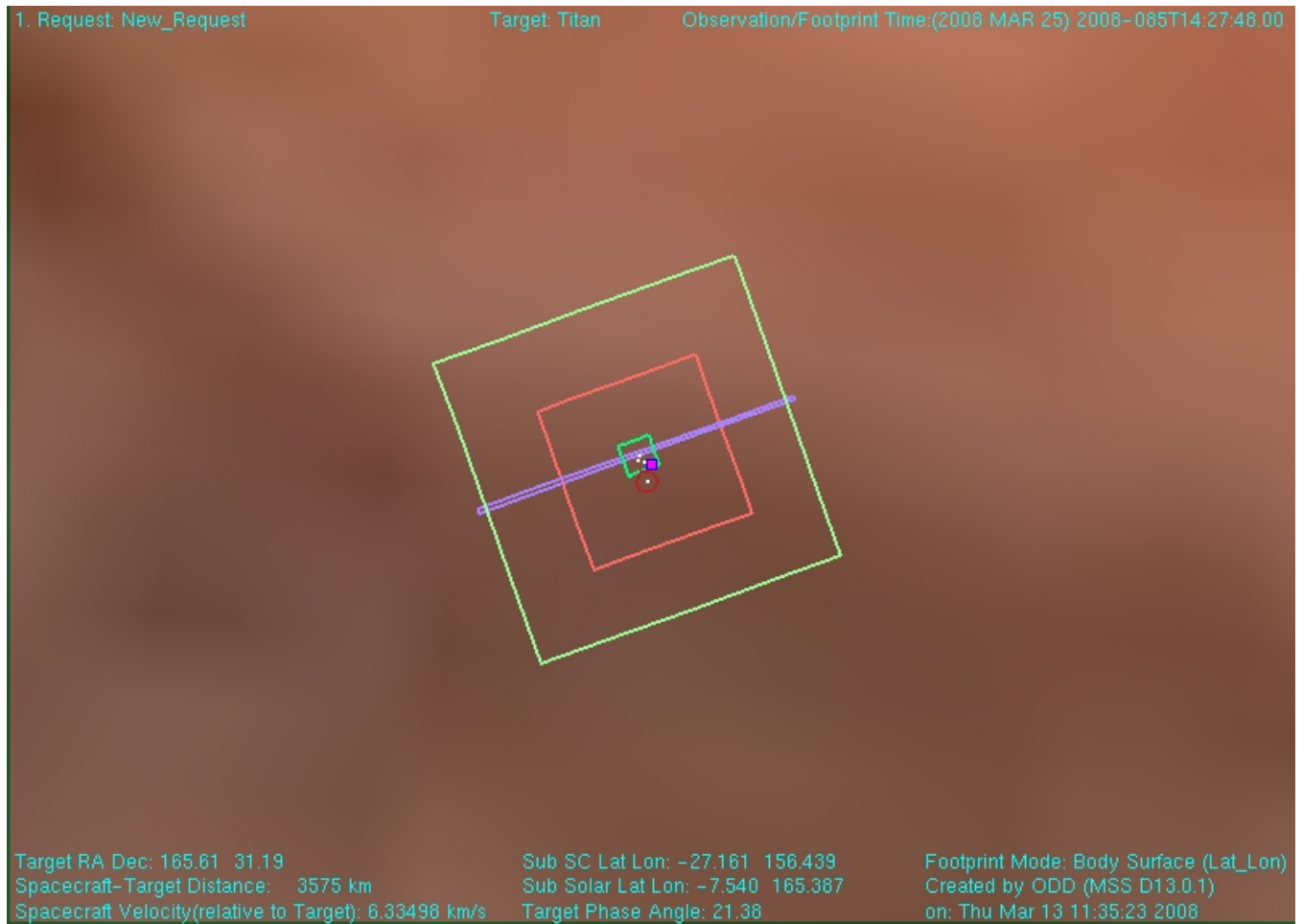
Key to ORS Instrument Fields of View in Figures

Instrument Field of View	Depiction in Figure
ISS WAC (imaging wide angle camera)	Largest square
VIMS (visual and infrared mapping spectrometer)	Next largest pink square
ISS NAC (imaging narrow angle camera)	Smallest green square
CIRS (composite infrared spectrometer) – Focal Plane 1	Small red circle near ISS_NAC FOV
UVIS (ultraviolet imaging spectrometer)	Vertical purple rectangle centered within largest square

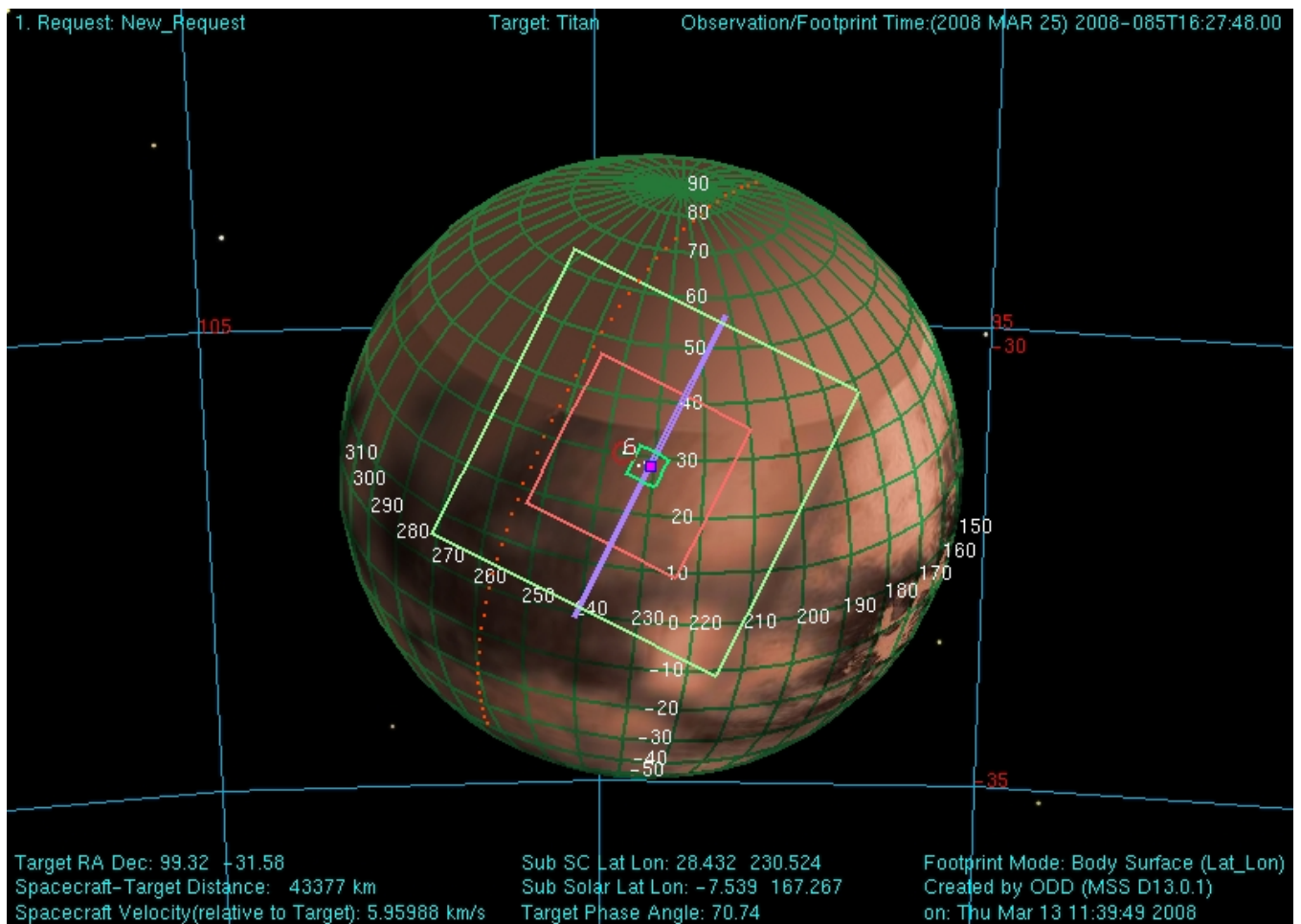
View of Titan from Cassini two hours before Titan-42 closest approach



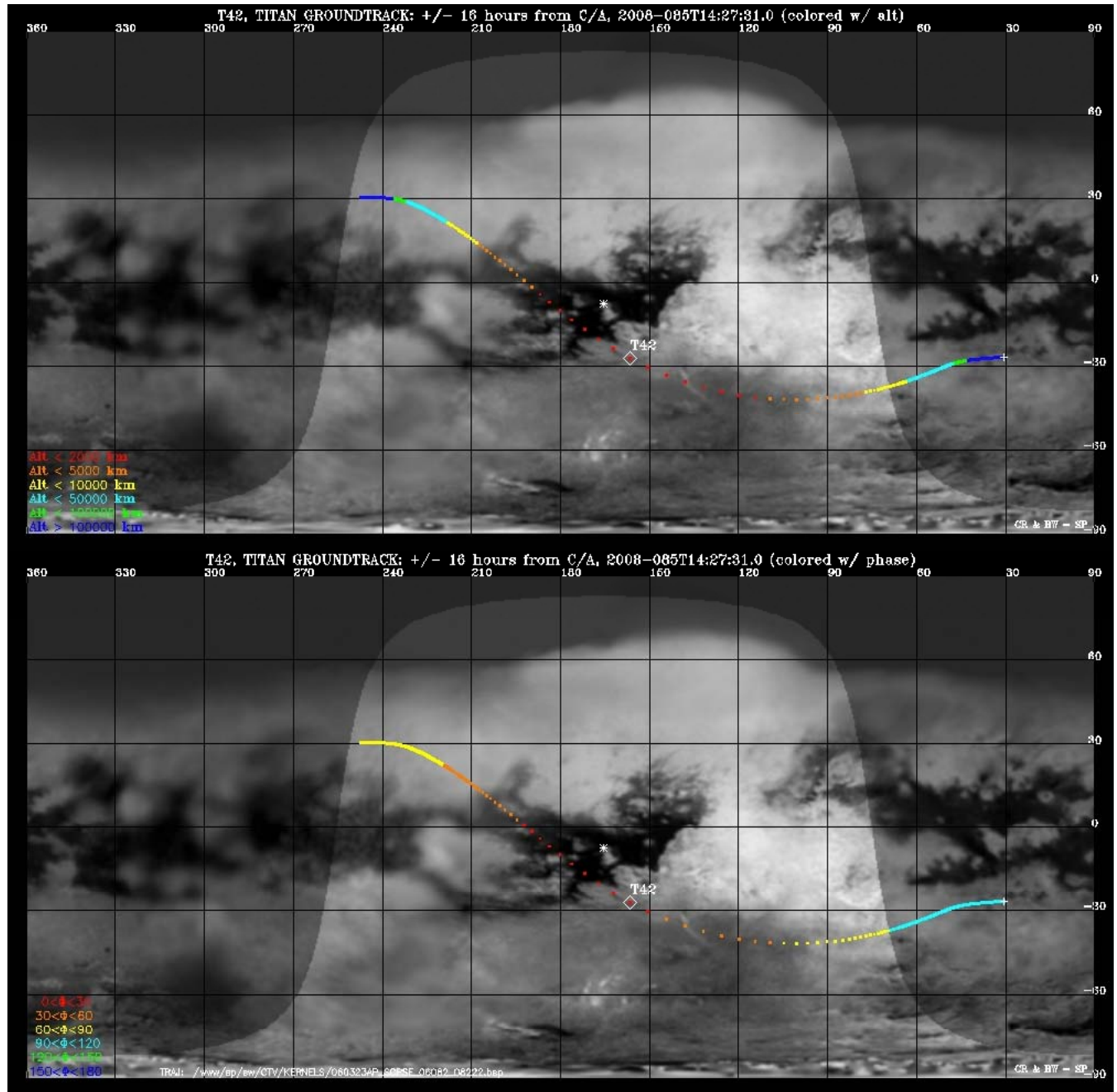
View of Titan from Cassini at Titan-42 closest approach



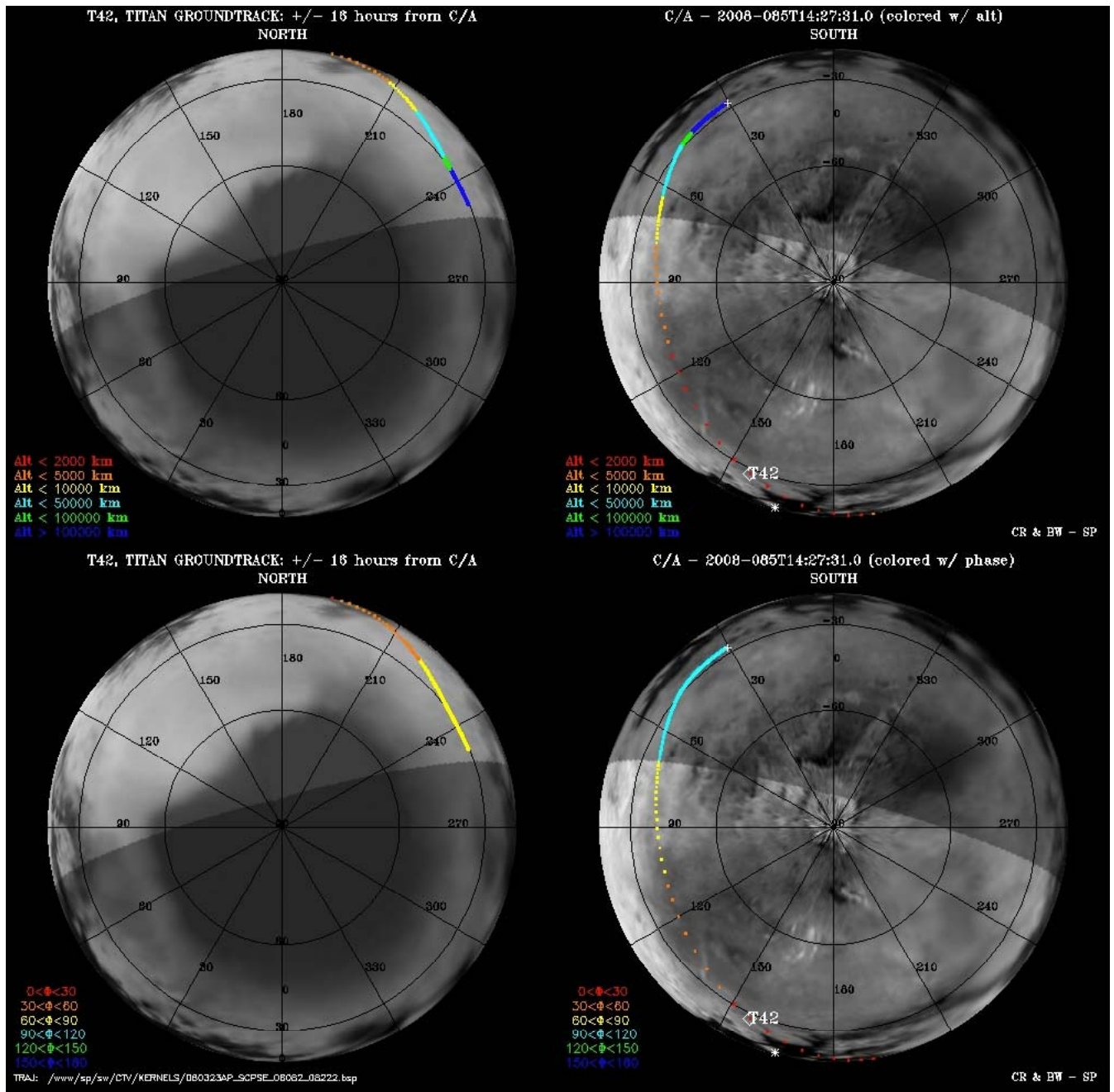
View of Titan from Cassini two hours after Titan-42 closest approach



Titan Groundtracks for T42: Global Plot



Titan Groundtracks for T42: Polar Plot



The T42 timeline is as follows:

Cassini Titan-42 Timeline - March 2008

Colors: yellow = maneuvers; blue = geometry; pink = T42-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T42	Activity	Description
082T16:50:00	Mar 22 18:00	Sat Mar 22 10:00 AM	T42-02d22h	OTM #151 Prime	Titan-42 targeting maneuver.
083T01:50:00	Mar 23 03:00	Sat Mar 22 07:00 PM	T42-02d13h	Start of Sequence S39	Start of Sequence which contains Titan-42
083T10:20:05	Mar 23 11:30	Sun Mar 23 03:30 AM	T42-02d04h	Descending Ring Plane Crossing	
083T10:36:48	Mar 23 11:46	Sun Mar 23 03:46 AM	T42-02d04h	Pallene Non-Targeted Flyby	Altitude = 32,565 km (~20,190 miles)
083T10:54:37	Mar 23 12:04	Sun Mar 23 04:04 AM	T42-02d04h	Epimetheus Non-Targeted Flyby	Altitude = 84,132 km (~52,160 miles)
083T11:24:18	Mar 23 12:34	Sun Mar 23 04:34 AM	T42-02d03h	Methone Non-Targeted Flyby	Altitude = 102,556 km (~63,585 miles)
083T12:10:49	Mar 23 13:20	Sun Mar 23 05:20 AM	T42-02d02h	Saturn Periapse	Saturn periapse, R = 3.7 Rs, lat = -23 deg, phase = 149 deg
084T00:20:00	Mar 24 01:30	Sun Mar 23 05:30 PM	T42-01d14h	OTM #151 Backup	
085T01:35:00	Mar 25 02:45	Mon Mar 24 06:45 PM	T42-12h52m	Start of the TOST segment	
085T01:35:00	Mar 25 02:45	Mon Mar 24 06:45 PM	T42-12h52m	Turn cameras to Titan	
085T02:05:00	Mar 25 03:15	Mon Mar 24 07:15 PM	T42-12h22m	New waypoint	
085T02:05:00	Mar 25 03:15	Mon Mar 24 07:15 PM	T42-12h22m	Deadtime	7 minutes 48 seconds long; used to accommodate changes in flyby time
085T02:12:48	Mar 25 03:22	Mon Mar 24 07:22 PM	T42-12h15m	Titan atmospheric Observations-VIMS	Cloud Map
085T05:27:48	Mar 25 06:37	Mon Mar 24 10:37 PM	T42-09h00m	Titan atmospheric observations-CIRS	Obtain information on trace constituents in Titan's stratosphere. Integrate on limb at two positions.
085T09:27:48	Mar 25 10:37	Tue Mar 25 02:37 AM	T42-05h00m	Titan atmospheric observations-CIRS	Obtain information on surface & tropopause temperatures, and on tropospheric CH ₄ . Scan or contiguous steps across disk.
085T12:27:48	Mar 25 13:37	Tue Mar 25 05:37 AM	T42-02h00m	Transition to thruster control	
085T12:28:48	Mar 25 13:38	Tue Mar 25 05:38 AM	T42-01h59m	Titan atmospheric observations-CIRS	Vertical sounding of stratospheric compounds on Titan, including H ₂ O. Integrations at 2 locations on the limb displaced vertically.
085T13:12:48	Mar 25 14:22	Tue Mar 25 06:22 AM	T42-01h15m	Titan atmospheric observations-CIRS	Vertical aerosol sounding of Titan's stratosphere.
085T13:37:48	Mar 25 14:47	Tue Mar 25 06:47 AM	T42-00h50m	Titan atmospheric observations-CIRS	Vertical temperature sounding of Titan's tropopause & stratosphere.
085T14:06:48	Mar 25 15:16	Tue Mar 25 07:16 AM	T42-00h21m	Turn cameras to New Waypoint	
085T14:12:48	Mar 25 15:22	Tue Mar 25 07:22 AM	T42-00h15m	New waypoint	
085T14:12:48	Mar 25 15:22	Tue Mar 25 07:22 AM	T42-00h15m	Titan Magnetosphere and Plasma Science Campaign-INMS	Determine atmospheric and ionospheric composition and thermal structure.
085T14:27:48	Mar 25 15:37	Tue Mar 25 07:37 AM	T42+00h00m	Titan-42 Flyby Closest Approach Time	Altitude = 1000 km (628 miles), speed = 6.3 km/s (14,000 mph); 21 deg phase at closest approach
085T14:42:48	Mar 25 15:52	Tue Mar 25 07:52 AM	T42+00h15m	Turn cameras to New Waypoint	
085T14:54:48	Mar 25 16:04	Tue Mar 25 08:04 AM	T42+00h27m	New waypoint	
085T14:54:48	Mar 25 16:04	Tue Mar 25 08:04 AM	T42+00h27m	Titan surface observations-VIMS	High Resolution Mapping of landing site.
085T15:09:42	Mar 25 16:19	Tue Mar 25 08:19 AM	T42+00h42m	Ascending Ring Plane Crossing	
085T15:13:48	Mar 25 16:23	Tue Mar 25 08:23 AM	T42+00h46m	Transition off of thruster control	
085T15:35:48	Mar 25 16:45	Tue Mar 25 08:45 AM	T42+01h08m	Titan surface observations-VIMS	high-resolution cubes of Titan's surface
085T16:27:48	Mar 25 17:37	Tue Mar 25 09:37 AM	T42+02h00m	Titan surface observations-ISS	High resolution regional map
085T18:27:48	Mar 25 19:37	Tue Mar 25 11:37 AM	T42+04h00m	Titan atmospheric observations-CIRS	Obtain information on surface & tropopause temperatures, and on tropospheric CH ₄ .
085T19:27:48	Mar 25 20:37	Tue Mar 25 12:37 PM	T42+05h00m	Titan atmospheric observations-CIRS	Obtain vertical profiles of temperatures in Titan's stratosphere.
085T23:27:48	Mar 26 00:37	Tue Mar 25 04:37 PM	T42+09h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH ₄ . Integrate on disk at airmass 1.5--2.0.
086T01:27:48	Mar 26 02:37	Tue Mar 25 06:37 PM	T42+11h00m	Titan atmospheric observations-ISS	Monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes, 1-3 km/px
086T03:27:48	Mar 26 04:37	Tue Mar 25 08:37 PM	T42+13h00m	Titan surface observations-VIMS	Regional map
086T04:27:48	Mar 26 05:37	Tue Mar 25 09:37 PM	T42+14h00m	Titan surface observations-VIMS	Global map
086T15:34:48	Mar 26 16:44	Wed Mar 26 08:44 AM	T42+01d01h	Deadtime	15 minutes 12 seconds long; used to accommodate changes in flyby time
086T15:34:48	Mar 26 16:44	Wed Mar 26 08:44 AM	T42+01d01h	Turn to Earth-line	
086T16:20:00	Mar 26 17:30	Wed Mar 26 09:30 AM	T42+01d02h	Playback of T42 Data	Madrid 70 arrayed